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Partitioning the Effects of Weather and Air Pollution on Human Mortality in Santiago, Chile

INTRODUCTION

One of the greatest challenges in modern epidemiology has been quantifying the impact on human health of prolonged exposure to air pollution. Meanwhile, because of the growing concern over the health consequences of climate change, numerous studies have examined the impact of extreme weather conditions on health. The present study applies a temporal synoptic index to consider the composite effect of multiple meteorological elements on human health. In repeated analyses, in diverse climates, researchers applying this method have found weather to be a better predictor of mortality than pollution. The present study asks whether the same findings hold true in Santiago, Chile, a city with one of the worst air pollution problems in Latin America.

STUDY AIMS

1.) Identify regional weather patterns associated with poor air quality and elevated cause-specific mortality

2.) Quantify the magnitude and timing of mortality response to stressful weather and pollution conditions.

3.) Do cardiovascular, respiratory, and total mortality demonstrate different sensitivities?

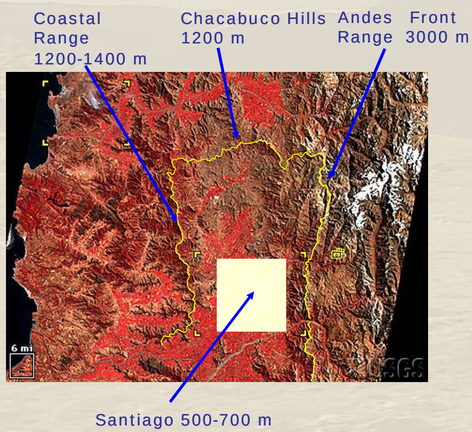

Figure 1. Santiago, Chile: Regional topography forms a closed basin, trapping air pollution

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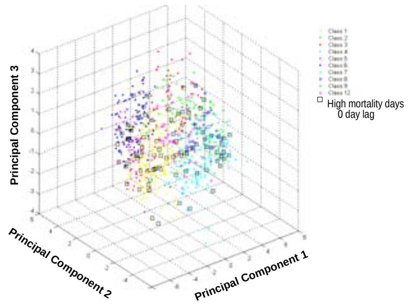

Figure 2. Results of the cluster analysis for weather classes. High-mortality classes were determined bases on a the density of high-mortality days.

RESULTS

NO_2 levels were significantly associated with total and respiratory mortality, though the relationship was weaker than that of temperature or dew point with mortality. The effect of extreme weather was strongest at short lag times (zero to three days), while the effect of pollution was strongest at longer lag times (three to six days).

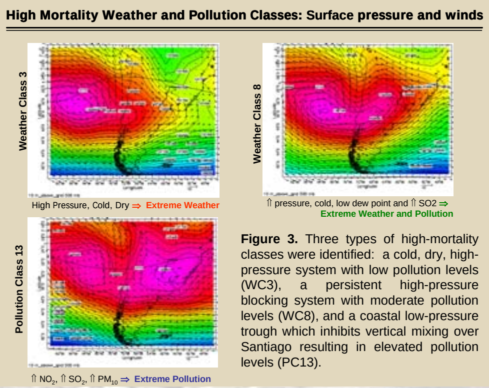

Figure 3. Three types of high-mortality classes were identified: a cold, dry, high-pressure system with low pollution levels (WC3), a persistent high-pressure blocking system with moderate pollution levels (WC8), and a coastal low-pressure trough which inhibits vertical mixing over Santiago resulting in elevated pollution levels (PC13).

METHODS

Each day in the study period was assigned to both a weather classes and a pollution class using a synoptic temporal classification scheme (Figure 2). Descriptive statistics were used to describe stressful pollution and weather conditions. Forward stepwise multiple regression was used to determine the relative importance of weather and pollution variables in explaining the variation in excess deaths.

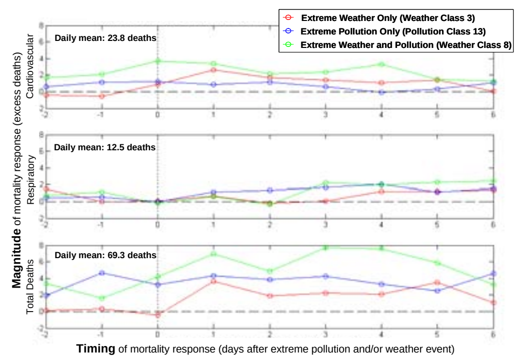

Figure 4. Differential impacts of pollution and weather on mortality: Cardiovascular deaths were more sensitive to extreme weather conditions, while respiratory deaths were more sensitive to high pollution levels.

CONCLUSIONS and BROADER IMPACTS

Pollution levels and weather conditions were both significantly associated with the number of excess deaths. Cardiovascular mortality is most sensitive to temperature at short lag times, and is marginally sensitive to $PM_{2.5\text{-}10}$. Respiratory mortality was most responsive to humidity and NO_2 at longer lag times. Applications of this methodology include improving pollution warnings and weather watch systems and helping to define research priorities with respect the human health impacts of global climate change.